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ANALOG III DEVICES INC.

NORWOOD — MASSACHUSETTS

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INSTANT ACTION REQUEST

Send detailed literature on:

D/A Converters

- ☐ MDA-H, DAC-H
- ☐ DAC-Q
- ☐ DAC-QS, DAC-QM
- ☐ MDA-U, MDA-L
- ☐ DAC-M
- ☐ MDA-F
- ☐ DAC-16QM, DAC-16QG
- ☐ DAC-10D

A/D Converters

- ☐ ADC-H
☐ ADC-Q
☐ ADC-QM
☐ ADC-U
☐ ADC-F

- ☐ μ DAC Brochure
(IC D/A Components)

- ☐ Multiplexers
- ☐ Sample & Holds
- ☐ Power Supplies

Send information on following specific products:

Model

Price Quote on quantities of

Check to receive
evaluation unit

_____	_____	☐
_____	_____	☐
_____	_____	☐
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My needs are:

- ☐ immediate
- ☐ 3-6 mos.
- ☐ information only

My application involves:

I ☐ use ☐ plan to use
A/D and/or D/A converters

Have Salesman call at:

A/C	Tel.	Ext.
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		TWX: 610/492-2383
Quebec	Whittaker Electronics Ltd.	514/683-3621
		TWX: 610/422-3980
Saskatchewan	Whittaker Electronics Ltd.	416/247-7454

May, 1971

Dear Sir:

Analog Devices has continually led the data conversion field with true state-of-the-art products. Some of these accomplishments have been:

- | | |
|------|---|
| 1968 | First modular D/A, the "Minidac [®] " |
| 1969 | Fastest modular A/D, the 1 μ sec "ADC-F" |
| 1970 | First 12-bit integrated circuit D/A's, the " μ DAC [™] line" |

We have delivered thousands of these A/D's and D/A's to our customers. Our record of innovative designs is unsurpassed by any other.

Enclosed in this packet are some examples of 1971 designs that are of this caliber.

- | | |
|--------|--|
| MPX-8A | 8-Channel Multiplexer |
| SHA-1A | .01% Sample and Hold Amplifier |
| ADC-QM | 8, 10, and 12-bit High Performance A/D Converter |
| DAC-QS | 8, 10, and 12-bit High Performance D/A Converter |

We stand ready to provide any additional information you may need. Do not hesitate to ask for assistance.

Fred Molinari

Fred Molinari
Marketing Manager

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Permit No. 280
Norwood, MA.



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NEW DIGITAL SYSTEM COMPONENTS FROM ADI

Analog Devices continues the expansion of its line of module system components for data acquisition systems with the announcement of several new products. These products are electrically and mechanically compatible with each other, and with many others of Analog Devices' products. All operate from standard power sources of $\pm 15V$ and $+5V$; some do not require all of these voltages. All units are compatible with DTL/TTL logic. The data acquisition and distribution systems that can be assembled from these components will meet the needs of a very large percentage of all industrial and scientific requirements, for both computer-coupled and free-standing digital data systems.

The ADC-QM is a series of modular A/D converters, available in 8-, 10-, and 12-bit versions. Complete with input buffer amplifier and reference, these fast converters ($25\mu s$ for 12-bits) are packaged in $2" \times 4" \times 0.4"$ modules. All models are fully monotonic over the operating temperature range ($0^\circ C$ to $+70^\circ C$). Price: ADC-8QM \$250.

The MPX-8A is an 8-channel high-speed multiplexer, and can be used either as an 8-channel single-ended switch or as a 4-channel differential switch. Switch address control is by binary code; the addressing logic has an extender gate and three uncommitted inverters, allowing up to 64 switching channels to be addressed without need for additional logic elements. The MPX-8A handles signal levels up to $\pm 10V$ with $\pm 15V$ power. Module size is $2" \times 2" \times 0.4"$. Price: \$175.

The DAC-12QM is a completely self-contained D/A converter, also available in 8- and 10-bit versions. The DAC-QM is complete with input register, monolithic IC converter switches and thin-film resistor network, reference supply with amplifier, and output amplifier with provisions for the user to program output range by means of jumpers at the module terminals. Settling time is 5 microseconds. The device is packaged in a $2" \times 4" \times 0.4"$ module. Price: DAC-8QM \$170.

The DAC-QS is a series of D/A converters very similar to the DAC-QM's, except for the omission of the input register. Otherwise the units are electrically identical. The DAC-QS is mounted in a smaller module only $2" \times 2" \times 0.36"$. Price: DAC-8QS \$140.

The DAC-16QM is a 16-bit resolution version of the DAC-12QM. It offers the ultimate in resolution, linearity, and stability. Settling time for the current output is under 3 microseconds to 0.0015%. The DAC-16QM is offered in versions with 14- and 16-bit linearity. Input registers are not included, since provisions for registers are made on the companion DAC-16QG manifold board, along with provisions for many other useful options. The DAC-16QM is packaged in a module 2" X 4" X 0.4". Price: DAC-16QM \$745.

The DAC-16QG is a manifold board which accepts DAC-QM's from 8 to 16 bits, and offers several optional circuit supplements that result in true state-of-the-art performance. The options include: a "Deglitcher" for limiting switching transients to 5 millivolts; an input register with provisions for one of five popular input codes; and a choice of high performance amplifiers, for optimizing settling time, stability, or cost. The DAC-16QG is built on a printed circuit card, 4.5" X 4.75". Price: DAC-16QG ranges from \$820 to \$1,145.

The SHA-IA, SHA-III, and SHA-IV are sample-and-hold amplifiers designed for the requirements of a wide variety of applications in sampled data systems, such as data acquisition and data distribution. All are high accuracy (0.01%) devices with unity gain. The major differences among these models lies in their settling speeds: SHA-IA is 5 microseconds to 0.01%; SHA-III is 100 microseconds; SHA-IV is 20 microseconds. All are packaged in modules: SHA-IA is 2" X 2" X 0.4"; SHA-III and SHA-IV are 1.1" X 2" X 0.4". Prices: SHA-IA, \$150; SHA-III, \$95; SHA-IV, \$120.

APPLICATIONS

This extremely versatile and high-performance group of products is ideally suited to the construction of digital data acquisition, control, and distribution subsystems. In addition, the D/A converters are extremely useful in the construction of CRT display terminals.

The compact modules are designed for mounting on printed circuit cards, and result in very compact assemblies. A complete 8-channel data acquisition system, consisting of an MPX-8A, a SHA-IA, an ADC-12QM, and an address program counter for the MPX-8A can be built on a single printed circuit card only 4" X 6".

The DAC-QM is a complete self-contained digital-to-analog converter module, available in 8-, 10-, and 12-bit versions. Complete with strobed data entry to the input register, the module is offered wired for a variety of binary codes as well as BCD. Logic levels are compatible with DTL and TTL. The output amplifier circuit is exceptionally versatile, utilizing jumper programming at the module terminals to allow the user to determine the output range and offset. The DAC-QM module also contains monolithic μ DAC current switches, a thin film resistor network, and a reference supply with amplifier.

The DAC-QS is a much smaller module without input register, but is nonetheless a complete digital-to-analog converter in all respects, and is also available in 8-, 10-, and 12-bit versions. The internal μ DAC AD550 converter switches are driven directly by complementary binary and complementary BCD input logic, without need for a strobe. In all other respects, the DAC-QS is electrically identical to the DAC-QM.

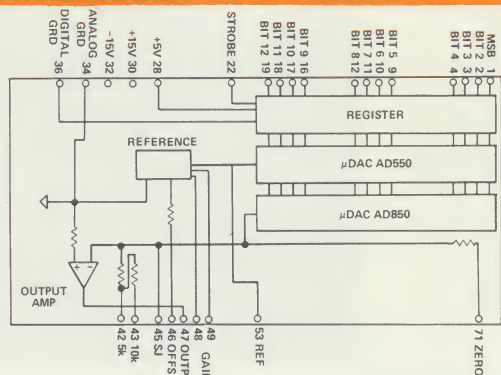
The DAC-QM and DAC-QS are module versions of the popular DAC-Q card mounted D/A converter. Each is a complete converter, containing the new IC μ DAC AD550 quad current switches, precision thin film resistor networks, reference supply with amplifier, and the versatile output operational amplifier. The units are electrically identical, except for omission of the input register from the DAC-QS, in order to allow a package with appreciably reduced dimensions. For operation, they require only input data, dc power, and trimmer potentiometers for zero and gain.

The input storage register built into the DAC-QM can be provided for a variety of codes. Binary, 2's complement and Binary-Coded-Decimal are all offered. Special input coding is not required for Offset codes, such as Offset Binary. The DAC-QS, having no input register, accepts complementary binary code and complementary BCD.

Provisions for variations in output characteristics are exceptionally versatile. By means of jumpers between terminals of the module, the user can select any one of five combinations of range and offset, to comply with the needs of the application. The choices are:

Bipolar : $\pm 2.5V, \pm 5V, \pm 10V$

Construction of the new DAC-QM and DAC-QS series centers around the new monolithic μ DAC IC D/A components. The Model AD550 quad current switches are used in conjunction with thin film AD850 resistor networks. The AD550 IC switches are designed for optimal temperature tracking. The thin film resistor network includes all the critical gain-determining resistors. A high gain reference amplifier assures that all variations in switch parameters are ideally compensated. The interquad attenuation network is 16:1 for binary and 10:1 for BCD.



Block Diagram

DAC-QM

DIGITAL-TO-ANALOG CONVERTERS

SECRET
INGREDIENTS
product



8-, 10-, 12-Bit Resolutions and Accuracies

Low TC ($\pm 7\text{ppm}/^\circ\text{C}$)

Complete with Register (DAC-QM)

Binary or BCD Coding

Output Range Customer Programmed

Output Ranges Available:

+5V, +10V, $\pm 2.5V$, $\pm 5V$, $\pm 10V$

**Excellent Power Supply Rejection
(0.002%/ % V_S)**

Low-Profile Modules

ANALOG DEVICES 

ROUTE ONE INDUSTRIAL PARK
P. O. BOX 280 NORWOOD, MASS. 02062
TEL: 617/329-4700 TWX: 710/394-6577

DAC-QM AND DAC-QS

Digital-to-Analog Converters

SPECIFICATIONS (Typical @ +25°C unless otherwise noted)

MODEL	DAC-QM	DAC-QS
RESOLUTION	- 8QM 8-bits - 10QM 10-bits - 12QM 12-bits	- 8QS 8 bits - 10QS 10 bits - 12QS 12 bits
DIGITAL INPUTS		
"0" $E < +0.8V$	@ -3.2mA	@ -1.6mA
"1" $+2 < E < +6V$	@ +80μA	@ +100μA max
	TTL Compatible	*
STROBE	Data transfers from inputs to register on "0" to "1" change. Width at least 50ns, "0-1" transition at least 100ns after data change	No Strobe
INPUT CODES	Binary, 2's Compl., BCD	Compl. Binary & Compl. BCD
OUTPUT RANGES	0 to 5V } @ 10mA (User programs ±2.5V, ±5V) 0 to +10V } @ 5mA (with jumpers) ±10V	* * *
OUTPUT IMPEDANCE	0.02Ω	*
CONVERSION SPEED	5μs to 0.01%	*
Slewing Rate	20V/μs	*
LINEARITY	±½LSB	*
TEMP. COEFFICIENT		
Linearity	±3ppm/°C of Reading max	*
Gain	±7ppm/°C max	*
Zero	±15μV/°C max	*
TEMP. RANGE		
Standard	0°C to +70°C	*
Optional	-55°C to +125°C ¹	*
POWER REQUIRED	+15VDC @ +25mA -15VDC @ -30mA +5VDC @ +150mA	* * +5VDC @ +35mA
POWER SUPPLY SENSITIVITY	0.002%/supply ΔE (±15VDC supplies only)	*
ADJUSTMENTS		
(User Provides)		
Gain Adj.	100Ω pot	20kΩ pot
Zero Adj.	20kΩ pot	*
PRICES (1-9)		
DAC- 8	\$170.	\$140.
DAC-10	\$210.	\$170.
DAC-12	\$230.	\$190.
DAC- 8-ET	\$340.	\$280.
DAC-10-ET	\$420.	\$340.
DAC-12-ET	\$460.	\$380.

*Specifications same as Model DAC-QM

¹Use model number suffix ET (for extended temperature)

Specifications subject to change without notice

ORDERING GUIDE: DAC-QM AND DAC-QS

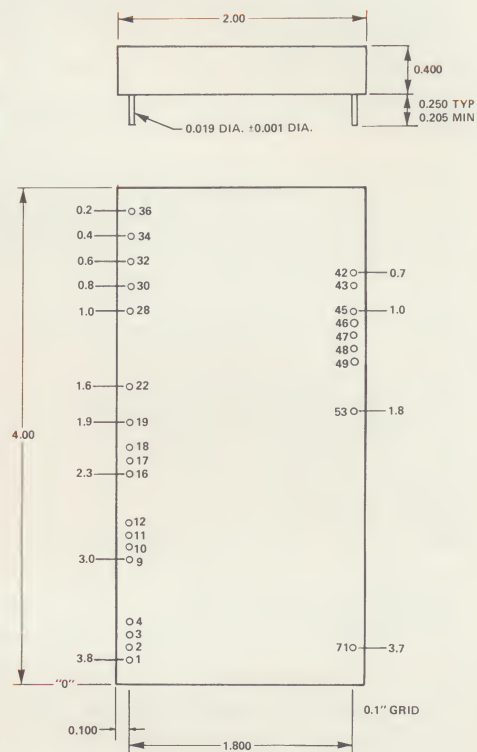
Model No. DAC	XX	XX	/ XXX	/ XX
	No. of Bits	Series	Input Code	Temp Range
Conv. Type	8 10 12	QM QS ²	BIN (binary) C-B (comp. binary) ² 2SC (2's comp.) BCD CBD (comp. BCD) ²	SN (Standard) ET (Extended) ¹

¹Use Model number suffix ET (for extended temperature)

²DAC-QS available ONLY with Complementary Binary or Complementary BCD. These codes not available in DAC-QM.

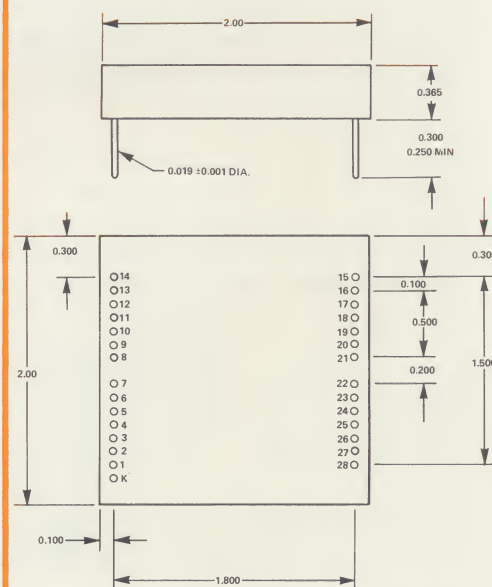
OUTLINE DIMENSIONS (In Inches)

DAC-QM



BOTTOM VIEW

DAC-QS



BOTTOM VIEW

JUMPER PROGRAMMING

The output amplifier circuit of the DAC-QM and DAC-QS is jumper programmed at the module terminals, allowing the user to determine which one of five possible output ranges will be used.

Feedback resistance value is determined by jumpers at C, D, E, and F. Jumpers allow using one 5k resistor, or both, either in series to provide 10k, or parallel to provide 2.5k.

Offset of exactly $\frac{1}{2}$ of full scale is provided by connecting the jumper between A and B. To maintain constant load on the reference zener, it is necessary to jumper point B to ground whenever it is *not* jumpered to point A.

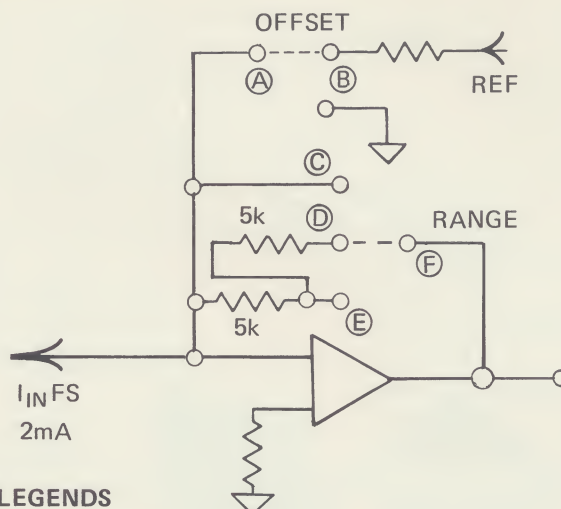
NOTES:

A bipolar output range must be used with bipolar input codes such as 2's complement or offset binary.

In BCD versions, value of the individual feedback resistors is 4k, allowing use of 8k feedback resistance to provide output range of 0 to +10V (direct reading).

PROGRAMMING TABLE

RANGE	R_F	OFFSET	GND(B)
$\pm 10V$	10k	Yes	No
+10V	5k	No	Yes
$\pm 5V$	5k	Yes	No
+5V	2.5k	No	Yes
$\pm 2.5V$	2.5k	Yes	No



PIN LEGENDS

	QM	QS
A	45	27
B	46	21
C	45	27
D	43	23
E	42	24
F	47	26

PIN CONNECTIONS AND ADJUSTMENT POT CONNECTIONS

TOP VIEW
ACTUAL LABEL

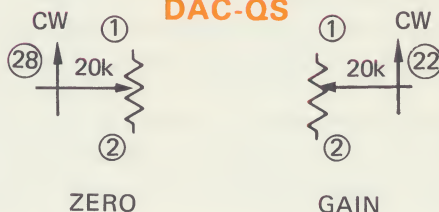


POTENTIOMETER CONNECTIONS
for Zero + Gain Adj.

DAC-QM



DAC-QS



NOTES:

- Binary Units of less than 12 bits: MSB of input logic connects to labeled MSB input pin of DAC-QM/QS. The connections left off are those at the LSB end.
- BCD Units:
 - 8 and 12-bit—MSB to MSB pin.
 - 10-bit—MSB of input logic connects to Bit 3 pin. No connection to Bit 1 (labeled MSB) or to Bit 2 pin.

TOP VIEW
ACTUAL LABEL



DAC-Q FAMILY CROSS COMPARISON

PARAMETER	DAC-Q	DAC-QS	DAC-QM
Resolution	8 / 10 / 12	8 / 10 / 12	8 / 10 / 12
Register	Optional	No	Yes
Strobe	Only with Register	No	Yes
Input Logic Codes	BIN C-B OBN COB 2SC C2C BCD CBD	Complementary Binary & BCD	BIN 2SC BCD
Output Range	+5, +10, ± 2.5 , ± 5 , ± 10 Factory Wired	+5, +10, ± 2.5 , ± 5 , ± 10 Customer Programs	+5, +10, ± 2.5 , ± 5 , ± 10 Customer Programs
Speed — Standard — Optional	50 μ s to 0.01% 2.5 μ s to 0.01%	5 μ s to 0.01%	5 μ s to 0.01%
Power +15V 25mA —15V 30mA +5V at	with register 150mA w/o register 25mA	35mA	150mA
Adjustments	Gain & Zero pots on unit	Customer provides 2 ea. 20k Ω pots for Gain and Zero Jumper programming provided for user to set 1. Output range, as indicated above 2. Output offset of $\frac{1}{2}$ FS, as needed for above ranges	Customer provides 100 Ω gain adj. and 20k Ω Zero pots
Size	Card: 4.5" $\times$ 4.114" inc. edge connector 0.474H, Standard Ampl. 0.662H, Fast Option	Module: 2" $\times$ 2" $\times$ 0.36"	Module: 2" $\times$ 4" $\times$ 0.4"
Prices w/o register w/ register For Fast Amp, add	\$135. / \$165. / \$185. \$165. / \$205. / \$225. \$50.	\$140. / \$170. / \$190.	\$170. / \$210. / \$230

MOUNTING BOARDS

Mounting boards are available for both the DAC-QM and the DAC-QS. These boards have pin sockets into which the modules are plugged, and input/output connections are brought to the edge connector. Mounting boards are complete with potentiometers for zero and gain adjustment.

Mounting Board	DAC-QM	Model 4494-1	\$40. each
	DAC-QS	Model 4516	\$40. each
Mating connector (supplied) is Cinch (250-22-30-170)			

MINIMIZING SWITCHING TRANSIENTS DURING CONVERSION

All digital-to-analog converters have switching transients (usually called "glitches") in their outputs. These transients are caused by the fact that the turn-off time of the converter switches is not exactly the same as the turn-on time. Analog Devices has developed a "deglitcher" capable of limiting the amplitude of these switching transients to about 5 millivolts. It can be applied only to specific circuit configurations, and the DAC-QM is compatible.

The transient suppression circuit is an optional component of a manifold board (the DAC-QG) on which can be mounted an appropriate D/A converter of the DAC-QM series to provide "glitchless" conversion, with resolution of 8-, 10-, 12-, 14-, or 16-bits. If your application requires clean, transient limited output wave forms, we suggest that you call the factory for further information.

GENERAL DESCRIPTION

The MPX-8A is a complete 8-channel high-speed MOSFET multiplexer packaged in a small encapsulated module; it is compatible both in package and electrical input/output characteristics with other Analog Devices hybrid interface products such as sample-and-hold, and analog-to-digital and digital-to-analog converters. The MPX-8A was designed for applications requiring high accuracy, high throughput rates, and minimal crosstalk.

ADDRESS SELECTION LOGIC

The TTL compatible binary address selection logic has all the needed logic elements required to expand the multiplexer to 64 signal channels, whether each channel is single-ended or differential. Mode control, programmed by the user with a jumper at the Module terminals, determines whether each MPX-8A module operates as an 8-channel single-ended switch or a 4-channel differential switch.

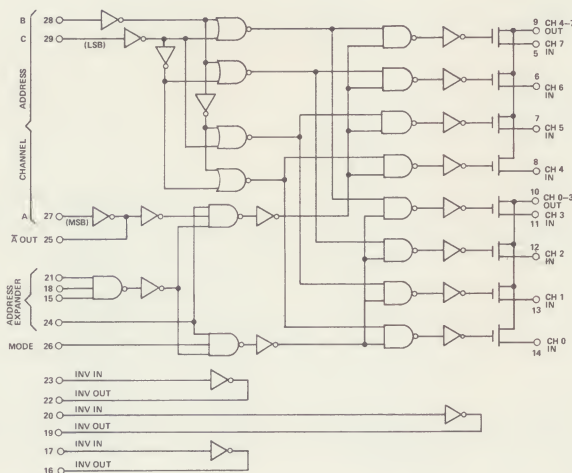
Unlike many other MOSFET multiplexers currently available, the MPX-8A settles at very high speed regardless of the input slewing direction. In most cases, system throughput rate will be limited by associated equipment, since the "worst case" switching time is $2\mu\text{s}$. Optimum case switching time is 300–400ns.

BENEFITS OF ADVANCED DESIGN

The MPX-8A is unique in providing the advantages of MOSFET switching over a signal range of $\pm 10\text{V}$ with power supply of only $\pm 15\text{V}$. Being a unipolar device, the MOSFET switch contributes no offset voltage to the signal being processed. Advanced guarding techniques minimize switch capacitance, minimize crosstalk, and optimize switching speed. Since the MOSFET requires gate excitation to turn on, the MPX-8A turns off all switches upon removal of power, thus guarding active signal sources against damage by inadvertent turn on of more than one channel. The binary address control guards against inadvertent turn-on of more than one channel at a time, further protecting active signal sources from damage.

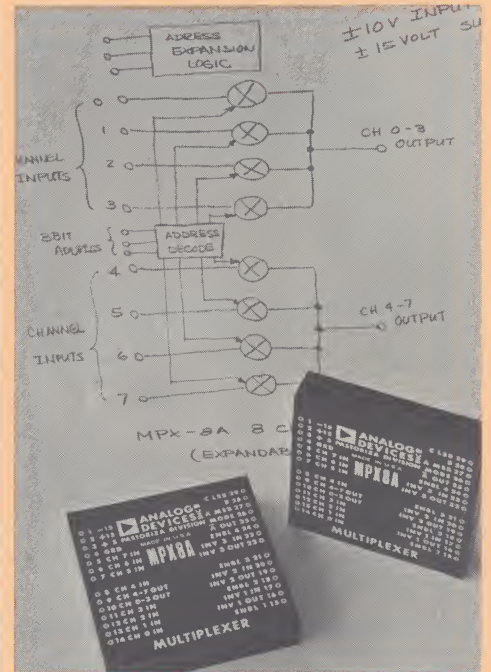
IMPEDANCE AND ACCURACY CONSIDERATIONS

Since the MPX-8A is a switch with ultra-high insulation resistance, the resistive component of input impedance and the effective transfer error are really determined by the characteristics of the following buffer amplifier. When followed by a high quality fast buffer, such as Analog Devices Model 45, input impedance will be on the order of 10^{10} ohms and transfer accuracy will be better than 0.01%.



LOGIC FLOW DIAGRAM – MPX-8A

MODEL MPX-8A MULTIPLEXER



FEATURES

- 8-Channel Single-Ended or 4-Channel Differential
- MOSFET Switches
- DTL/TTL Compatible
- Binary Address Selection
- $\pm 10\text{V}$ Range with $\pm 15\text{V}$ Power
- $\pm 15\text{V}$ Max Allowable Input
- Crosstalk –80dB
- Settling Time $< 2\mu\text{s}$ to 0.01%

APPLICATIONS

- Data Acquisition
- Data Distribution
- Independent Switching



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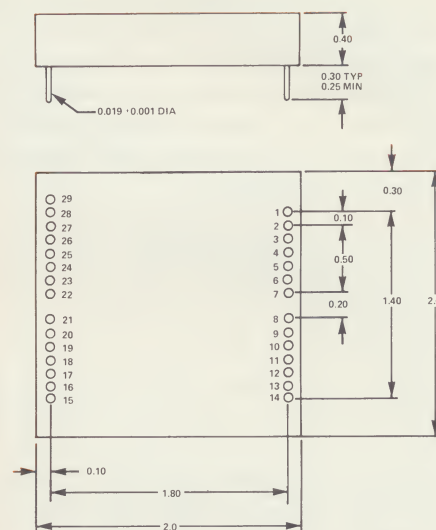
MPX-8A MULTIPLEXER

SPECIFICATIONS (typical @ +25°C unless otherwise noted)

MODEL	MPX-8A
CHANNELS	8 Single-ended, or 4 Differential (programmable by user)
VOLTAGE RANGE	
Normal Operating	-10V to +10V
Overvoltage Protection	-15V to +15V
CROSSTALK	< -80dB
TRANSFER ACCURACY	Determined by following Amplifier. Values to <0.01% readily attainable
INPUT IMPEDANCE	Determined by following Amplifier. Values to 10 ¹⁰ ohms readily attainable
COMMON MODE REJECTION	Determined by following Amplifier. Values to 120dB available
ANALOG SWITCHES	MOSFET Transistors
SWITCH CHARACTERISTICS (EACH CHANNEL)	
ON Resistance	1000 ohms
OFF Resistance	1000 megohms, min
Input Capacitance	10pF
Leakage Capacitance (OFF Channels)	<3pF
ON Input Leakage Current @ +25°C	10nA, max
@ +70°C	100nA, max
Settling Time to 0.01%	< 2μs
THROUGHPUT RATE	Rates to 500kHz. Practical high limit is determined by accessory equipment, as well as nature of signals
FAULT PROTECTION	1. Binary address selection makes it impossible to select more than one channel at a time 2. MOSFET switches return to "OFF" state whenever power is lost or removed
ADDRESS CONTROL	
Code	Binary
Logic	TTL/DTL Compatible
"1"	E > +2.4V @ +40μA, or Open Circuit
"0"	E < +0.8V @ -1.6mA
Channel Address	3-bit Binary Code turns on one of 8 Switches
Mode Control	Jumper at module terminals determines whether module operates as 8-channel single-ended, or 4-channel differential switch
Address Extender (4 input AND gate)	All Inputs at Logic "1" enables module addressing. Provides for system expansion to 64 channels, either single-ended or differential
Logic Inverters (3, uncommitted)	Provide all logic elements required for full expansion of system
Module Disable	A logic "0" at any input of extender gate opens all switches in module
POWER	+15V ±1V @ 6.2mA -15V -1V + 0 @ 4mA +5V ±10% @ 102mA
TEMPERATURE	
Operating	0°C to +70°C
Storage	-65°C to +150°C
SIZE	2" X 2" X 0.4" Module
PRICE (1-9)	\$175.

Specifications subject to change without notice

OUTLINE DIMENSIONS (In Inches)



BOTTOM VIEW

PIN DESIGNATION

TOP VIEW ACTUAL LABEL



DECIMAL TO BINARY TRUTH TABLE

0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

INSTRUCTIONS FOR ADDRESSING

SWITCH ADDRESS SELECTION IN A MODULE

Desired switch address is the switch channel number (0–7); the 3 bit binary code is applied to module pins 27, 28, and 29. Pin 27 is the MSB. See table at left.

SINGLE-ENDED OR DIFFERENTIAL OPERATION

Jumping to pin 26 (MODE or "pairing" control) determines the operating mode.)

- For 8-channel single-ended operation, jumper pin 26 to pin 25. ("A" connects to mode control)
- For 4-channel differential operation, jumper pin 26 to pin 27. ("A" connects to mode control)

SYSTEM EXPANSION

All logic elements are provided in each MPX-8A module to allow system expansion to 64 channels (each channel either differential or single-ended), which would involve use of 8 MPX-8A modules (for 64-channel single-ended) or 16 MPX-8A modules (for 64-channel differential).

On each module, pins 15, 18, 21, and 24 are effectively 4 inputs to an AND gate, and logic "1" must be presented to each in order to enable the module for switch opening. Since open circuit at each input acts as a logic "1", unneeded gate inputs need only be left unconnected to allow use of the module. Thus, a single module used as an 8-channel single-ended switch needs no connections to the expander gate. Note, however, that any one of the expander

gate inputs can be used to open ALL switches in a module, by applying a logic "0".

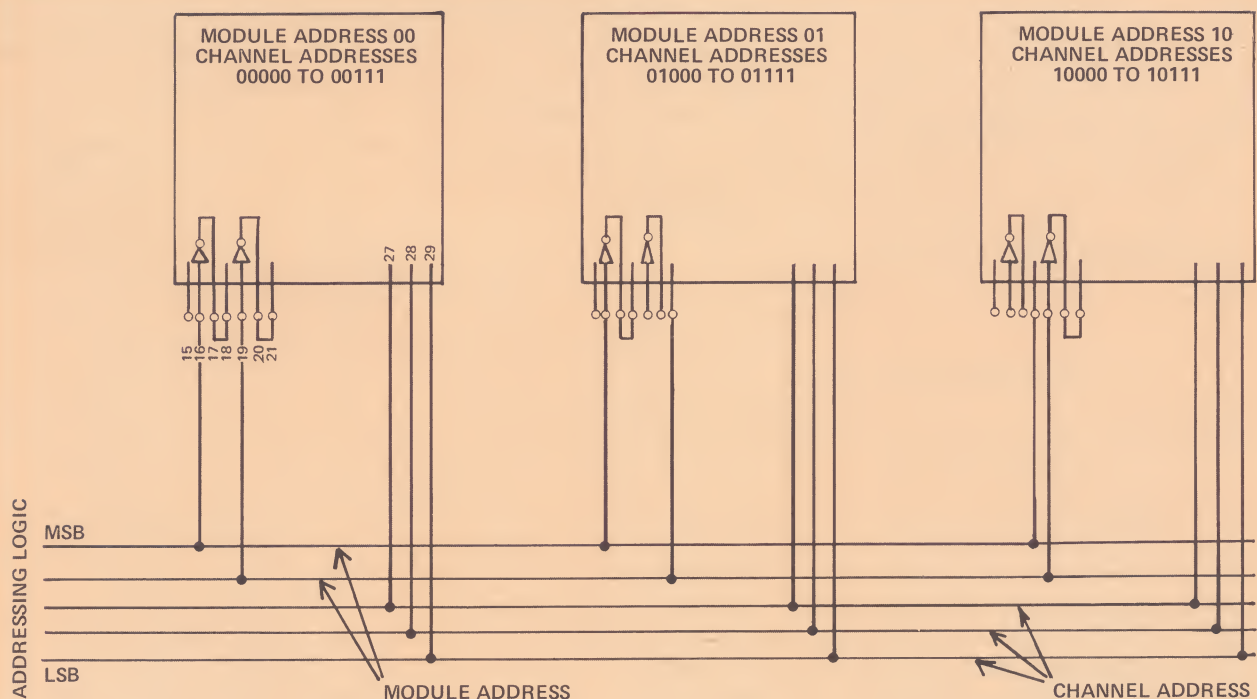
EXAMPLE OF EXPANDED SYSTEM WIRING

In the figure entitled "Address Programming Example," we see the address wiring for a 24-channel single-ended system, consisting of 3 MPX-8As. A 5-bit addressing code is required, and would actually suffice for further expansion to 32-channels.

The 3 bits of channel address logic are wired to all 3 MPX-8As in parallel, to pins 27, 28, and 29 (MSB to pin 27, LSB to pin 29). The proper addressing of one of the three MPX-8As via connections to the extender AND gate (via inverters, where necessary) is required to determine which of the 3 modules is enabled.

When module address code is 00, module 00 must be enabled. Since "1" must be presented to the expander gate inputs, the 2 bits of module address code must be fed to the gate inputs through inverters. Note that the inverters are conveniently connected to pin numbers between the extender gate inputs, to simplify the locating of jumpers.

In like manner, the module address code lines going to modules 01 and 10 require use of one inverter each: for addressing 01, the inverter is located in the MSB line; for addressing 10, the inverter is located in the 2nd MSB line.



ADDRESS PROGRAMMING EXAMPLE
24-Channel Single-Ended System
Consisting of 3 MPX-8A's

APPLICATIONS OF THE MPX-8A

GENERAL

Accurate and easily addressable multiplexers, such as the MPX-8A, are the key to cost control in computer data acquisition. For it is the time sharing characteristic of the system that results in cost sharing of the relatively expensive computer among many data channels, and brings down the "per-channel" equipment cost to highly competitive levels.

The following system examples are typical of the role of the multiplexer in contemporary data system design. All of these examples can be implemented with compatible components manufactured by Analog Devices, Inc.

DATA ACQUISITION SYSTEM

The data acquisition system of Figure 1 is the engineer's workhorse for this application. The multiplexer address can be programmed either directly by computer, or by a free-standing address programmer, as shown in the block diagram. For sequential addressing, the programmer is a simple binary counter, with input coming from the status signal of the ADC. A system of this type, assembled from standard units manufactured by Analog Devices (MPX-8A, SHA-1A, ADC-8F) is capable of sequential measurements on the 8 input channels at a throughput rate of over 100kHz.

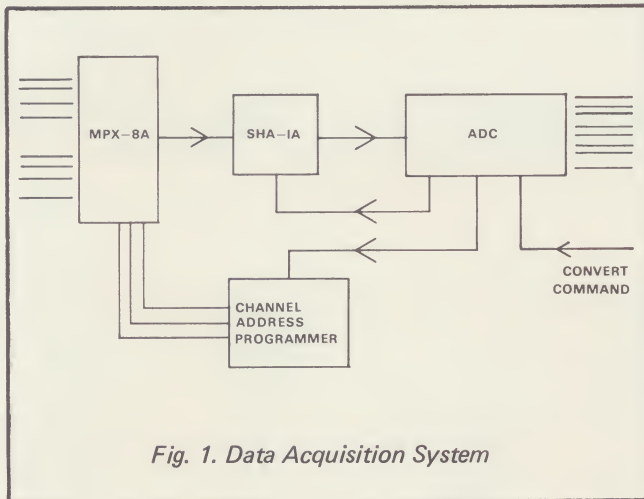


Fig. 1. Data Acquisition System

SIMULTANEOUS SAMPLE-AND-HOLD

Work in the fields of explosives and shock waves frequently requires measurement of several transducers as of exactly the same instant of time. This measurement program is accomplished easily by the simultaneous sample-and-hold technique, diagrammed in Figure 2. All sample-and-holds are switched to "HOLD" simultaneously, then scanned and read out by the MPX-8A and the A/D converter. With the system components shown, all channels can be scanned in as little as 24 μ s. The last MUX channel selected has drooped only 2.4 μ V during the complete scan cycle.

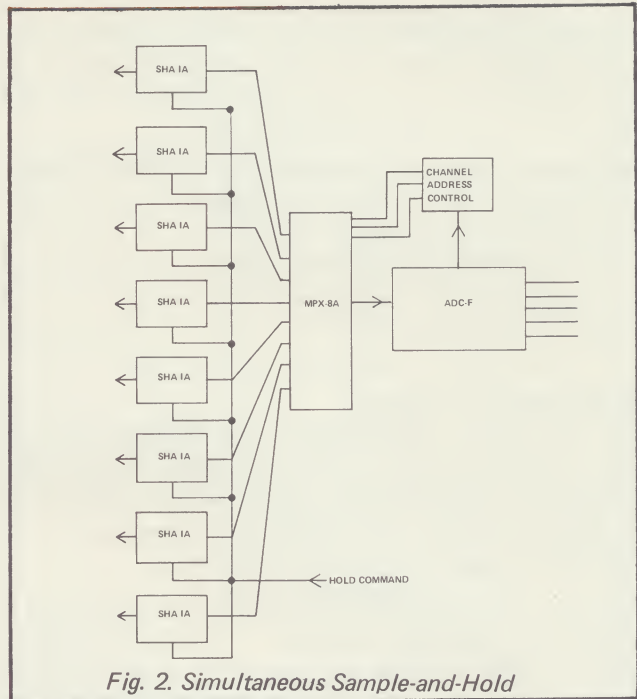


Fig. 2. Simultaneous Sample-and-Hold

DATA DISTRIBUTOR

Since sample-and-hold amplifiers are appreciably less expensive than high performance DACs, sizeable economies can sometimes be realized by distributing the analog data output of the DAC via multiplexer and SHA. Each sample-and-hold maintains essentially constant output signal while the system scans around and updates all other output channels. A system of this type can update output at a rate of about 125kHz. At this rate, in an 8 channel system, SHA outputs will droop only 6.4 μ V before being updated.

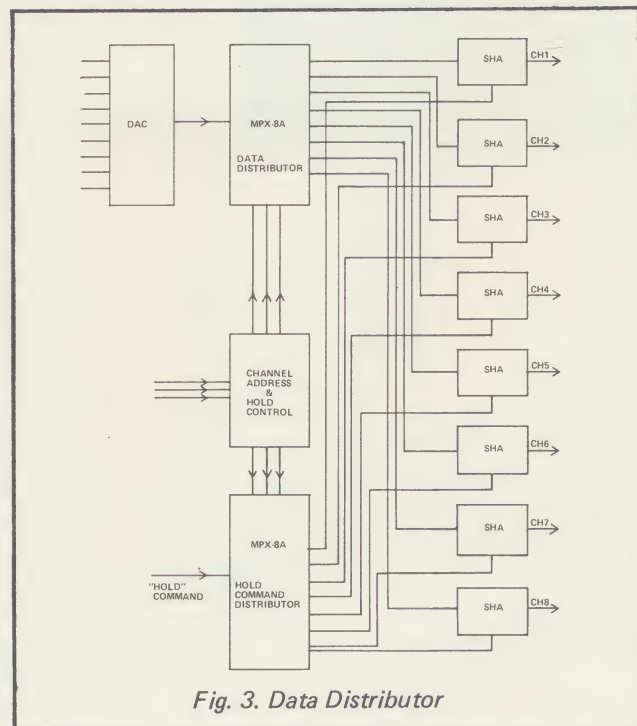


Fig. 3. Data Distributor

GENERAL DESCRIPTION

The SHA IA is a fast sample-and-hold module with low droop rate and overall accuracy compatible with 12-bit A/D conversion systems operating to ½LSB accuracy. When in the “sample” mode, the module appears as a fast amplifier with 5μs settling time to 0.01%, 1nA input current, 25μV/°C drift, and unity gain with ±10V at ±20mA output current capability. When in the “hold” mode, the droop rate is 50μV/ms max, so the SHA IA will hold an input signal to 0.01% of full scale (20V p-p) for 40ms, sufficient for 12-bit A/D conversion.

SAMPLE TO HOLD CHARACTERISTICS

Of prime importance in selecting Sample-and-Hold amplifiers is the transition characteristics when the module is commanded into hold by the digital control line. A finite delay will occur between initiation of the hold command, and actual disconnection of the hold capacitor from the input buffer amplifier. In the SHA IA, this delay time is 40ns maximum. The uncertainty, or jitter over which this delay time will vary from cycle to cycle, as the module is repeatedly commanded into hold, is ± 5 ns. In most systems, the jitter specification is the limiting factor on overall system speed for a given accuracy, since fixed delays can be removed by adjusting the system timing. The 5ns jitter specification means the SHA IA can track a signal slewing up to $0.2\text{V}/\mu\text{s}$, and "capture" that signal to within a 1mV accuracy for A/D conversion.

OVERALL ACCURACY

The SHA IA is guaranteed to have an overall throughput non linearity of 2mV max over a $\pm 10\text{V}$ input range, or 1mV max over 0 to +10V inputs. This specification combines the effects of common mode errors, gain non linearity and sample to hold offset non linearity. It is no longer necessary to guess at the combined effects of individual errors since the SHA IA specification guarantees that its total non-linearity errors are sufficiently low to insure $\frac{1}{2}\text{LSB}$ accuracy in 12-bit systems.

GROUNDING

Many data acquisition systems suffer from digital ground induced noise appearing in the analog system. To counteract this problem, the SHA IA has three separate ground systems. The digital ground is actually one side of a differential amplifier, with the Sample/Hold digital control input being the other input of this amplifier. This effectively prevents digital ground noise from being impressed into the analog signal channel. The power ground and analog input/output grounds are also separate, so that power supply ground noise is reduced by the rejection coefficients of the amplifiers, normally well over 90dB. Ground connection instructions are given in Figure 1.

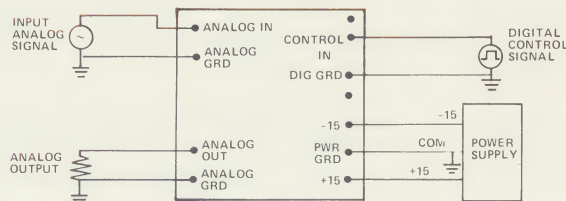


Fig. 1 SHA IA Connections and Grounding

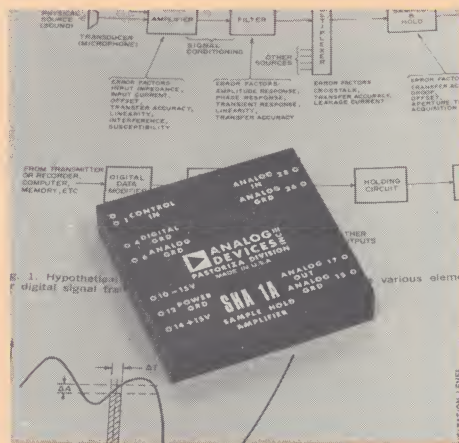
A DC path must exist between the Analog, Digital, and power supply grounds. Multiple grounds on signal and power return lines should be avoided. If possible, only one external ground should exist on the Analog ground system

SHA 1A

SAMPLE AND HOLD MODULE

FEATURES

12-Bit System Compatible
Throughput Non-Linearity 2mV
Max Over $\pm 10V$ Input Range
Acquisition Time $5\mu s$ Max
Input Buffer, $10^{12} \Omega R_{in}$
Independent Digital, Analog,
and Power Grounds
Modular 0.4" High Construction
Standard $\pm 15VDC$ Power
No External Adjustments
Required



APPLICATIONS

Data Acquisition Systems
Data Distribution Systems
Track and Hold
Sample and Hold
Peak Measurement Systems

Represented By

ANALOG
DEVICES 

ROUTE ONE INDUSTRIAL PARK
P.O. BOX 280 NORWOOD, MASS. 02062
TEL: 617/329-4700 TWX: 710/394-6577

SHA 1A

SPECIFICATIONS (typical @ +25°C and nominal supply voltages, unless otherwise noted)

ACCURACY

Gain	+1
Gain Error	+0.0, -0.05% max
Total Throughput Non Linearity (Includes Gain and Sample to Hold Offset Non Linearities)	2mV max over $\pm 10V$ input range 1mV max over 0 to +10V or 0 to -10V input range

**FREQUENCY RESPONSE IN
SAMPLE MODE**

Small Signal -3dB	500kHz min
Slew Rate	4V/ μ s
Settling Time to 0.01% for 20 Volt Input Step	5 μ s max

SAMPLE TO HOLD SWITCHING

Aperture Delay Time	40ns max
Jitter (Cycle to Cycle Variance in Delay)	5ns peak
Switching Transient Settling Time (to $\pm 1mV$)	300ns

HOLDING CHARACTERISTICS

Droop Rate	50 μ V/ms max
Droop Rate vs. Temp.	$\times 2/10^\circ C$
Feedthrough (10kHz, 20V p-p input)	0.005% max

HOLD TO SAMPLE SWITCHING

Acquisition Time to 0.01% of Full Scale	5 μ s max
--	---------------

INPUT CHARACTERISTICS

Input Resistance	10^{12} ohms
Input Capacitance	5pF max
Input Bias Current	10nA max, 1nA typ
Initial Input Offset	1mV max
Offset vs. Supply	100 μ V/%
Offset vs. Temp.	25 μ V/ $^\circ C$ max
Input Voltage, Max. Safe	$\pm 15V$
Input Voltage, Normal Operation	$\pm 10V$

OUTPUT CHARACTERISTICS

Output Voltage, Current	$\pm 10V$ min at $\pm 20mA$ min
Maximum Load Capacitance at Output	500pF

DIGITAL CONTROL

Logic Levels (DTL/TTL Comp.)	
("1") Sample	+2V to +5.5V at 40nA
("0") Hold	-0.5V to +0.8V at 20 μ A

POWER REQUIREMENTS

$\pm 15VDC$ at +10mA, -15mA ($\pm 3\%$ tolerance on voltage)
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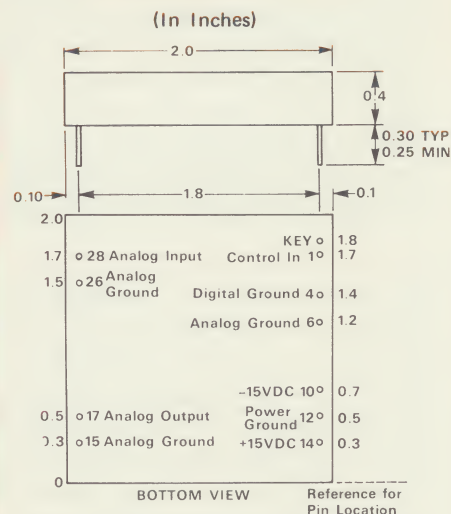
TEMPERATURE RANGE

Rated Accuracy	0°C to +70°C
Storage	-55°C to +85°C

PRICE 1-9

\$150.

Specifications subject to change without notice

**OUTLINE DIMENSIONS
AND
PIN CONNECTIONS**

Pins: 0.019 $\pm$ 0.001 dia, Gold plated rodar,
per MIL-G-45204 Class 1, type 2

Markings appear on top surface of module,
and are shown here on bottom view for
reference only.

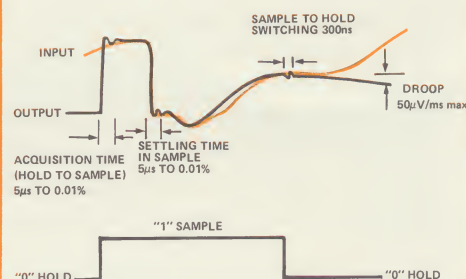


Fig. 2 Illustration of Dynamic
Specifications (not to scale)

OTHER PRODUCTS**Multiplexer MPX-8A**

Available with 8 channels, digital addressing, expandable to 64 channels. Input range $\pm 10V$ with standard $\pm 15VDC$ supplies. Mosfet design prevents burn out due to power failure, -80dB cross-talk, 2 μ s max switching time. Accuracy to 0.01%. Only \$175, 1-9 quantity.

Analog to Digital Converter ADC-H

Available in 8- or 10-bit accuracy and resolution. 18 μ s conversion time at 10 bits, modular 0.4" high, serial and parallel outputs. Only \$195 (8 bits) \$225 (10 bits).

Analog to Digital Converter ADC-QM

Available in 8-, 10-, or 12-bit resolution and accuracy. Extremely low TC's, 3ppm differential linearity. Another 0.4" high modular product. \$250 (8 bits) \$280 (10 bits) \$305 (12 bits).

GENERAL DESCRIPTION

The ADC-QM analog-to-digital converter is a high performance, low cost converter packaged in a low profile module. Monotonic over the full operating temperature range, QM series ADCs are available with resolution of 8-, 10-, or 12-bits. The ADC-QMs were designed to be capable of $\pm 1/2$ LSB absolute accuracy, when the required external Offset and Gain Adjust potentiometers are connected and adjusted against appropriate standards. The ADC-QM uses the technique of successive approximations to convert analog voltages in the range -10V to +10V (optional ranges available) to equivalent output binary and BCD numbers. For convenience in bipolar applications, Offset Binary and 2's Complement codes are offered; Binary and BCD are offered for unipolar applications. With its very tight specification on "Differential Linearity TC" (± 3 ppm/ $^{\circ}$ C, max) the Q and QM series A/D converters are completely monotonic over large temperature excursions.

UNIQUE DESIGN

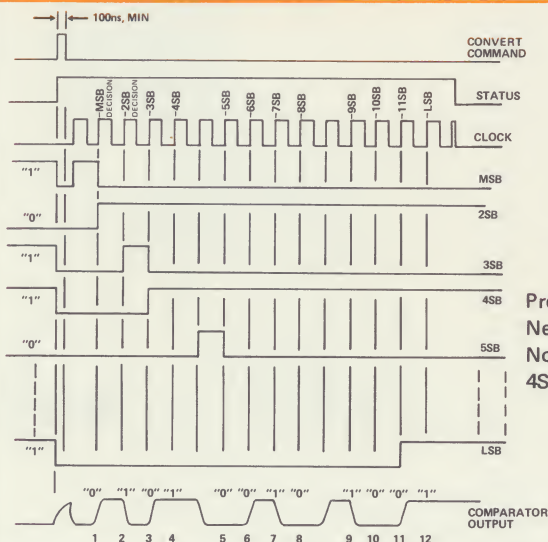
Design of the ADC-QM series is centered about the use of μ DAC IC converter switches and resistor networks. These outstanding components, developed by Analog Devices in order to attain optimum tracking of the most critical elements of D/A and A/D converters, are used in conjunction with standard 74 series TTL IC logic. It is the superb matching and tracking qualities of the μ DAC monolithic components that is responsible for the excellent performance of the Q series over temperature.

SMALL SIZE AND LOW POWER

Although the ADC-QM is very similar to the card-mounted Q version, a new logic design has resulted in the small module package (2" X 4" X 0.4") and sharply reduced power usage. Total power dissipation in the module is only 1.9 watts.

USER FLEXIBILITY

The ADC-QM can operate either with its own precision reference or a user-supplied external reference. The user determines, with jumpers at the module terminals, which of 3 available input ranges is in use: 0 to +10V, ± 5 V, ± 10 V. When bipolar input is selected, digital output code can be either offset binary or 2's complement (at user option). Only parallel data output is offered. Both status and its complement are provided, to allow synchronization of the ADC-QM with other components of the system, such as sample-hold amplifiers and multiplexers. An internal clock is provided, but an external clock can be used without need for synchronization with either internal clock or convert command. The input buffer may be connected or omitted, as appropriate for the application. The ADC-QM is compatible, both in package configuration and electrical input/output characteristics with many other hybrid interface products manufactured by Analog Devices, Inc.



MODEL ADC-QM ANALOG-TO-DIGITAL CONVERTERS

COMPLETE MODULAR A/D CONVERTERS TO 12 BITS WITH HIGH PERFORMANCE, LOW COST, AND MANY OPTIONS

a
SECRET
INGREDIENTS
product



FEATURES

- 8-, 10-, & 12-Bit Resolutions and Accuracies
- Low Cost/Performance Ratio
- Monotonicity Over Temperature
- Low (± 5 ppm/ $^{\circ}$ C) Gain TC
- Differential Linearity TC (± 3 ppm/ $^{\circ}$ C)
- High Supply Rejection (0.002%/V_S)
- Low Profile Module
- Binary or BCD Coding
- 55 $^{\circ}$ C to +125 $^{\circ}$ C Available



**ANALOG
DEVICES**

ROUTE ONE INDUSTRIAL PARK
P. O. BOX 280 NORWOOD, MASS. 02062
TEL: 617/329-4700 TWX: 710/394-6577

ADC-QM ANALOG-TO-DIGITAL CONVERTERS

SPECIFICATIONS (typical @ +25°C and nominal supply voltages, unless otherwise noted)

MODEL	ADC-QM		
RESOLUTION			
ADC- 8QM	8-bits or 2 digit BCD		
10QM	10-bits		
12QM	12-bits or 3 digit BCD		
ACCURACY			
Relative	±½LSB		
Quantization	±½LSB		
Monotonicity	Monotonic from 0°C to +70°C		
DIFFERENTIAL LINEARITY	< ±½LSB		
DIFFERENTIAL LINEARITY TC	±3ppm/°C, max (ADC-12QM)		
TEMPERATURE COEFFICIENT			
Gain	±5ppm/°C of Reading		
Zero	±5ppm/°C of F.S.		
CONVERSION TIME			
ADC- 8QM	18μs max	(from trailing edge of convert command to "1-0" change of status signal)	
10QM	22μs max		
12QM	25μs max		
INPUT VOLTAGE RANGES	±5V, ±10V, 0 to +10V (bipolar codes straddle 0V by ½LSB)		
INPUT IMPEDANCE			
Buffer	100 megohms, min		
Direct			
0 to +10V, or ±5V	5kΩ		
±10V	10kΩ		
INPUT TRIGGER	Positive pulse, 100ns wide, min		
(Convert Command)	Leading edge ("0" to "1") resets previous data		
(see Figure 1)	Trailing edge ("1" to "0") initiates conversion		
	TTL/DTL Compatible		
	"1" > 2.0V @ 40μA		
	"0" < 0.8V @ -1.6mA		
OUTPUT SIGNALS	Parallel, TTL/DTL Compatible		
(see Figure 1)			
OUTPUT CODES			
Unipolar	Binary, BCD		
Bipolar	Offset Binary, 2's Complement		
OUTPUT LEVELS			
"0"	< +0.4V } TTL/DTL Compatible		
"1"			> +2.4V }
STATUS (see Figure 1)	"1" during conversion		
STATUS COMPLEMENT	"0" during conversion		
POWER SUPPLY REQUIREMENTS	Analog		
(Separate Analog & Digital grounds)			+15V ±3% @ +25mA }
			-15V ±3% @ -35mA }
	+5V ±5% @ 200mA	Digital	
POWER SUPPLY SENSITIVITY	±0.002%/ΔV _S (±15V only)		
TEMPERATURE RANGE			
Operating	0°C to +70°C (suffix SN)		
	-55°C to +125°C (suffix ET) ²		
Storage	-55°C to +125°C		
ADJUSTMENTS			
(External Potentiometers Required)			
Zero:	100k pot across ±15 with 3 meg in series w/slider to pin 20		
Gain:	100k pot across ±15 with 30k in series w/slider to pin 1		
DIMENSIONS	2" X 4" X 0.4" Module		
PRICES (1-9)			
ADC- 8QM	\$250.		
10QM	\$280.		
12QM	\$305.		
8QM/ET ²	\$500.		
10QM/ET ²	\$560.		
12QM/ET ²	\$610.		

¹ On ADC-10QM, STATUS returns to "0" after 25 μ s, although conversion is complete after 22 μ s

² Use suffix ET to specify extended operating temperature range

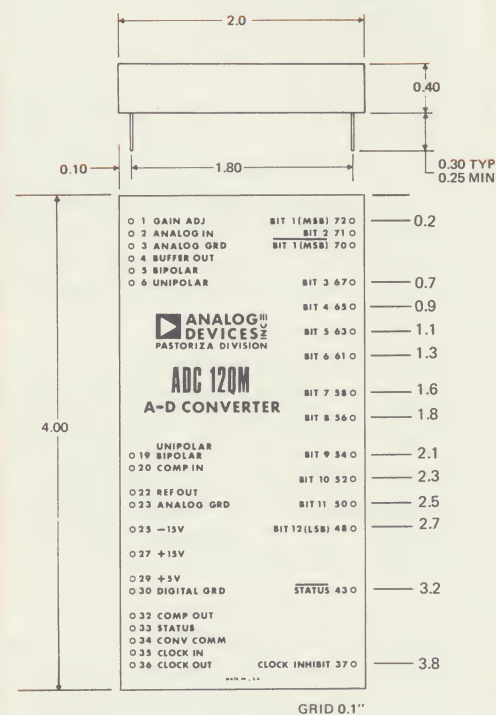
Specifications subject to change without notice

ORDERING GUIDE

ADC -	XXQM /	XXX /	XX
	No. of Bits	Output Code	Temp. Range
	8	BIN (binary)	SN (standard)
	10	BCD (binary coded decimal)	ET (extended)
	12		

OUTLINE DIMENSIONS AND PIN DESIGNATIONS

(In Inches)



TOP VIEW ACTUAL LABEL

For plug-in mounting on printed circuit boards use Board #4451 - \$25.00.

ADC-QM BLOCK DIAGRAM

